Multiresolution Landsat TM and AWiFS Sensor Assessment in Nebraska

Claire Boryan, Mike Craig, Rick Mueller, and Patrick Willis
703-877-8000
claire_boryan@nass.usda.gov
• Produce acreage estimates with reduced error rates over the June Agricultural Survey.

• Create and distribute the Cropland Data Layer Product.
19 Cropland Data Layer States
Multitemporal Landsat TM Scene Classification of Nebraska

Acquisition Dates: 07/03/04 & 07/19/04
Path/Row: 29/32
The Landsat Data Gap

Source: USGS, Landsat Project:
Indian Remote Sensing Satellite: RESOURCESAT-1

Advanced Wide Field Sensor (AWiFS)

- **AWiFS**: Swath: 370 km each head, 740 km combined, 56 m resolution at nadir, 70 m resolution at field edges.
- **Spectral Bands**
  - B2: 0.52-0.59 (Visible Green)
  - B3: 0.62-0.68 (Visible Red)
  - B4: 0.77-0.86 (Near Infrared)
  - B5: 1.55-1.70 (Middle infrared)

*Imagery required extensive (30 –50 pt.) registration of scenes vs. 1 pt registration for Landsat TM data*
Multitemporal Analysis of Nebraska using Landsat TM data
Nebraska – 2004
Unitemporal Analysis

**AWiFS**
Analysis Districts (AD)
and Scene Observation Dates

**Landsat TM**
Analysis Districts (AD)
and Scene Observation Dates
TM Multitemporal Classification

TM Unitemporal Classification
TM Unitemporal Classification

AWiFS Unitemporal Classification
Cuming County, Nebraska

AWiFS: 08/09/2004
BANDS: 4, 5, 3 (RGB)

LANDSAT 5 TM: 08/29/2004
BANDS: 4, 5, 3 (RGB)
Classified
Cuming County, Nebraska

AWiFS Unitemporal: 08/09/2004

TM Unitemporal: 08/29/2004
Segment Area Classifications

Multitemporal TM
4/07/04 & 08/19/04

Unitemporal LandsatTM
08/29/2004

AWiFS
08/09/2004
# Kappa Statistics for Classifier Accuracy

## Eastern Nebraska

### Corn

<table>
<thead>
<tr>
<th>Area</th>
<th>Multi</th>
<th>Uni</th>
<th>AWIFS</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD01</td>
<td>93.89%</td>
<td>73.42%</td>
<td>Uni</td>
</tr>
<tr>
<td>AD02</td>
<td>96.18%</td>
<td>93.54%</td>
<td></td>
</tr>
<tr>
<td>AD03</td>
<td>93.91%</td>
<td>92.67%</td>
<td></td>
</tr>
<tr>
<td>AD04</td>
<td>92.85%</td>
<td>89.90%</td>
<td></td>
</tr>
<tr>
<td>AD05</td>
<td>96.85%</td>
<td>93.22%</td>
<td></td>
</tr>
</tbody>
</table>

### Soybean

<table>
<thead>
<tr>
<th>Area</th>
<th>Multi</th>
<th>Uni</th>
<th>AWIFS</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD01</td>
<td>99.12%</td>
<td>93.39%</td>
<td>Uni</td>
</tr>
<tr>
<td>AD02</td>
<td>96.81%</td>
<td>89.93%</td>
<td></td>
</tr>
<tr>
<td>AD03</td>
<td>98.72%</td>
<td>93.40%</td>
<td></td>
</tr>
<tr>
<td>AD04</td>
<td>95.41%</td>
<td>88.37%</td>
<td></td>
</tr>
<tr>
<td>AD05</td>
<td>96.67%</td>
<td>85.69%</td>
<td></td>
</tr>
</tbody>
</table>

### Overall

<table>
<thead>
<tr>
<th>Area</th>
<th>Multi</th>
<th>Uni</th>
<th>AWIFS</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD01</td>
<td>96.91%</td>
<td>80.02%</td>
<td>Uni</td>
</tr>
<tr>
<td>AD02</td>
<td>96.19%</td>
<td>86.57%</td>
<td></td>
</tr>
<tr>
<td>AD03</td>
<td>95.60%</td>
<td>85.37%</td>
<td></td>
</tr>
<tr>
<td>AD04</td>
<td>93.50%</td>
<td>81.79%</td>
<td></td>
</tr>
<tr>
<td>AD05</td>
<td>92.88%</td>
<td>85.91%</td>
<td></td>
</tr>
</tbody>
</table>

**Analysis Districts & Scene Observation Dates**
Nebraska Land Use Stratification - 2004

- 80 % Cultivated
- 51 - 80% Cultivated
- 15 - 50% Cultivated
- Agri Urban
- Dense Urban
- <15% Cultivated
- Non-agricultural
- Water

Nebraska Unitemporal AWiFS Classification - 2004

Categories
- Corn
- Soybeans
- Other Row Crops
- Other Small Grains & Hay
- Winter Wheat
- Fallow/Idle Cropland
- Pasture/Grassland/NonAg
- Woods
- Clouds
- Water
- Urban
Regression Analysis from Unitemporal Sample Estimation

Landsat TM Corn
AD 24

AWiFS Corn
AD 69

R-sq (11,12,20) = 0.881
Slope (11,12,20) = 0.2376

R-sq (11) = 0.864
Slope (11) = 0.7230

R-sq (12, 20) = 0.699
Slope (12, 20) = 0.6033

Pixel Sq meter/-acres - .2224
Outliers Removed

Pixel Sq meters/ acres - .7747
Regression Analysis from Unitemporal Sample Estimation

Landsat TM Soybeans

AD 24

R-sq (11,12,20) = 0.922
Slope (11,12,20) = 0.2312

AWiFS Soybeans

AD 69

R-sq (11) = 0.869
Slope (11) = 0.7243
R-sq (12, 20) = 0.909
Slope (12, 20) = 0.7923

Pixel Sq meter/ acres- .2224
Outliers Removed
Pixel Sq meters/ acres - .7747
State Level Estimates as % Over/Under Agricultural Statistics Board (Final)

Source of Estimate

- June Ag
- TM-Mult
- TM-Uni
- AWIFS

% Over/Under ASB Final

- Corn
- Soybeans
State Level Estimates

 +/- 2 CVs (Coefficient of Variation)

Source of Estimate

% Over/Under ASB Final

-6 -4 -2 0 2 4 6 8 10 12 14

June Ag  TM-Mult  TM-Uni  AWIFS

Corn
Soybeans
Conclusions

- Classification results derived using the AWiFS data are not as accurate as those derived using either multitemporal or unitemporal Landsat data.

- Reductions in classification accuracy can be attributed to:
  - Spatial resolution - AWiFS (56m) vs. TM (30m)
  - Spectral Resolution - AWiFS (4 bands) vs. TM (7 bands)

- In the future, improvements in classification accuracy are likely to be achieved due to increased temporal frequency of the AWiFS sensor (5 day) vs. the TM sensor (16 day) repeat cycle.

- This should significantly increase the availability of cloud free imagery.
Conclusions

- AWiFS data appears acceptable for crop acreage estimation over large crop areas such as the Mid-West, the Delta and the Northern Great Plains.

- Furthermore, unitemporal AWiFS provided reasonable and consistent estimates for production of the Crop Land Data Layer product.

- We anticipate that use of multitemporal AWiFS data would improve the results to a level that is acceptable for NASS.